STUDY OF PREVALENCE AND WORK-RELATED RISK FACTORS FOR MUSCULO-SKELETAL DISORDERS (MSDs) AND THEIR CONSEQUENCES AMONG CONSTRUCTION AND SHOE MANUFACTURING WORKERS

SYNOPSIS

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1.0 INTRODUCTION

Small and Medium Scale Industries (SMEs) play a vital role in economic development of developing countries as well as developed countries. They play a crucial role in providing employment at low capital cost and industrialization. In developed countries SMEs are defined upon number of employees, whereas in India they are defined upon investment in plant and machinery. SMEs contribute 7% of gross domestic product (GDP), 40% of India's export, and help the economy with effective, efficient, and innovative entrepreneurial spirit. These give employment to about 60 million people, and produce more than 8000 products [1]. The labor intensity of this sector is much higher than that of large enterprises but their health and safety conditions are very poor in comparison with larger enterprises [2], [3].

The fundamental aim of ergonomics is to apply information about human behavior, abilities and limitations and other characteristics to the machines, design of tools, tasks, jobs and environments for productive, safe, comfortable and effective human use. As industries increasingly require higher production rates and advances in technology to remain competitive in market, the ergonomic study has become very important [4]. Ergonomics is a scientific discipline concerned with the understanding of interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Not only system performance but also health of employees could be improved by applying ergonomics [5]. The ergonomic approach is used to solve different problems of organized and unorganized sectors by optimizing the human machine environment interaction to utilize

human resources most efficiently without adverse effects [6]. Production environments of SMEs are human intensive. Hence human factors play an important role for enhancing productivity, reducing MSDs, loss of efficiency, and absenteeism from the workplace which is the typical issues of human based production systems [7]. The increased complexity of products, jobs, global competition, and lean production have imposed tremendous pressure on workers and cause the work stress [8]. Ergonomics aims to fit the job to the man and not to fit to the man to the job.

Manual Materials Handling (MMH) exposures are very complex in nature. It creates special problems for different workers worldwide. It is defined as the unaided movement of objects, often combined with twisting and awkward postures, and contributing to musculoskeletal disorders. Jobs in a variety of sectors (e.g. manufacturing, service, transportation, construction etc.) often require workers to perform multiple types of MMH tasks and in different stress demanding situations. The manual handling of tasks constitutes a considerable proportion of work done in industries around the globe, but particularly in developing areas. Manual load transport is still widespread in developing countries and has important socioeconomic implications because a significant proportion of the population derives their income solely by load carrying. Workers involved in manual work in industrially developing countries (IDCs) often have limited physical work capacities due to their poor socioeconomic status [9]. They are employed as laborers in construction sites, agriculture projects and in industries.

Traditionally labor oriented markets are on change towards more automation and mechanization, at the same time general awareness about occupational safety, occupational and environmental hazards were not spread in the society. With these structural changes the workers low resources settings are more likely to be affected by the dangers of high technology than their counterparts in developed countries. The number of persons earning their livelihood in India solely by working in awkward postures and carrying heavy load for small financial gain, ignoring their physical capacity, possible exhaustion and the dangers associated with handling of heavy loads and working in awkward postures. Due to lack of education, unaware of hazards of their occupations, general backwardness in sanitation, poor nutrition and climatic proneness of this geographic region to epidemics aggravate their health hazards from work environment [9].

Manual carrying has been a major source of hazards of industrial workers. Laborers engaged in jobs which require lifting/lowering, carrying and pushing/pulling of heavy materials are exposed to high risk of Musculoskeletal Disorders (MSDs). Musculoskeletal diseases may be considered as work related when aches and pains in the body region (e.g. shoulders, back) are associated with physical strain in these body areas during the course of work, and at the same time no other visible sign of general illness is affecting the musculoskeletal system.

A musculoskeletal disorder is a very common problem in industrial and service sectors. Musculoskeletal disorders are defined as pain and discomfort which affect muscles, joints, tendons, ligaments, nerves, and blood circulating veins system during work [10]. Most work related MSDs are cumulative disorders, due to repeated exposures to high-or-low intensity

stress over a long period of time. A Musculo-Skeletol symptom (MSS) is a significant health problem due to its serious economic and social impacts. For example 27% of all in Washington state funds accepted health insurance claims in 1997 to 2005 were for work-related musculoskeletal disorders (WMSDs), with an average direct cost of USD 12,377 per claim. In New Zealand, a report for National Occupational Health and Safety Advisory Committee (NOHSAC) indicated that 36% of the total compensation cost in 2005-2006 was due to sprains and strains, and 14% due to Musculo-Skeletol symptom (MSS). Body regions most commonly affected are the low back, neck, shoulder, wrist, and hand [10], [11]. Many studies have shown that factors like age, gender, Body mass index (BMI), and psychological characters are also risk factors for MSDs [12]. The social consequences of MSS may arise from reduced activities and absenteeism. The World Health Organization reported that musculoskeletal problems are the most important cause of physical disability. While the prevalence of MSS have been reported but less is known about their consequences. However, in the last two decades, some studies showed that psychosocial factors also played a role in developing MSS [13]. The findings also suggest that association between risk factors and MSS is multivariate and complex. It is suggested that both physical and psychosocial factors may independently influence low back symptoms (LBS) and their interaction is also suggested [14]. The interaction may give rise to a probability of LBS being greater than some of the magnitude of individual effect. The interaction studies of these individual factors in MSS are very limited.

Ergonomics risk factors are those characteristics of work which result ache, pain, discomfort and injury resulting from MSDs. These risk factors may be physical or psychosocial. The

following ergonomic risk factors are most likely to cause or contribute to MSDs: awkward postures, force, repetition, static postures, vibration temperatures, and contact stress [12], [15]. Highly repetitive work, forceful exertions, lifting, push/pull, and forceful movements and vibration are examples of risk factors that have been associated with increased reporting of MSDs [7], [12], [16], [17]. Study of ergonomics risk factors has become increased attention due to increase in number of injuries, absenteeism, and cost of illness. As per the report of American Federation of Labor and Congress of Industrial Organizations (AFLCIO 2012) there was an increase of 3.74% in MSDs [15]. The costs of occupational accidents were €55 billion a year in EU15 (15 European member states). The cost of MSD varies depending upon the definition of MSD of different countries [19]. Although, quite a lot is known about the risk factors for MSS, less is known about the risk factors for its consequences. Physical factors, including MMH and awkward posture are reported to be associated with reduced activities due to low back symptoms (LBS) only; awkward posture and whole body vibration have been found to be associated with absenteeism due to LBS only.

Only few studies have examined the interaction between risk factors for absenteeism with general absenteeism data and no specific absenteeism due to MSS has been considered.

2.0 LITERATURE REVIEW

In organized and unorganized industrial sectors the workers are often exposed to multiple risk factors for musculoskeletal disorders due to poor working conditions, and work pressure. The level of risk depends on the intensity, frequency and duration of the exposure to these conditions and the individual's capacity to meet the force or other job demands that might be involved. These conditions are more correctly called ergonomic risk factors for musculoskeletal disorders [20]. For an assembly task ergonomically designed workstations have positive effects on reducing cycle time and also help to increase work satisfaction [21]. Work organization, working time management, different work schedules also produce negative impacts on health of workers. Transitions in work time arrangements are related to change in health. Working long hours has been shown to be associated with poor subjective health, more injuries, unhealthy behavior, and increased morbidity and mortality. In load carrying activities health problems, fatigue, repetitive strain injury and MSDs are more predominant in women than in men. Very limited scientific studies on efficient and proper method of carrying loads in context of SMEs are available. SMEs have economical, technical as well as financial and other constraints that make it difficult to apply ergonomics principles especially in industrial developing countries [3], [22]. As SMEs are heterogeneous in nature and have lack of technology, knowledge and skilled manpower, it is difficult for them to promote sustainable development and well-being as compared to large scale industries [23].

Excess cardiovascular disease risk is reported in shift workers as BMI and ratio of low and high density lipoprotein cholesterol decrease in shift workers compared to the day workers

[24]. A study was conducted on handloom workers and reported that more than one third of subjects have had discomfort in the upper limb [25]. A study on agriculture workers carrying load was conducted and reported rates of MSD incidence ranked first amongst the highest risk industries [26]. A study on work related musculoskeletal problems among the women workers working in semi-conductor industry in Malaysia concluded that overall prevalence of body pain was 80.5% [27]. The result of Nordic musculoskeletal questionnaire (NMQ) revealed that WMSDs occurred at a very high rate [28]. A comparative study of seven modes of carrying an identical load on the level ground was conducted and found the Double Pack mode was ergonomically the best mode [29]. Considerable impact of work time arrangements on the individual worker, employers, and society was shown and suggested the need for interventions addressing work time arrangements in order to prevent their impact on employee health [30]. An ergonomic study on posture-related discomfort among preadolescent agricultural workers of West Bengal was conducted, while carrying load and concluded that workers suffer from discomfort or pain in different parts of their body specifically the lower back, neck and knee regions [31]. An investigation in brass metal industries in West Bengal, India showed that workers performing rigorous carrying and hand intensive jobs are likely to suffer from MSDs [32]. A study on the prevalence of musculoskeletal disorders among prawn seed collectors of Sunderbans, India showed that workers were working continuously in awkward postures and carrying loads during certain prawn seed collection activity and 62% of male prawn seed collector and 40% of female prawn seed collector suffered from severe pain before and after sleep at night [33]. A study on the effect of working posture on occurrence of musculoskeletal disorders among the sand core making workers of West Bengal, India concluded that the health of the workers was

highly affected by different awkward postures and load carried which creates different musculoskeletal disorders mainly in the low back region [34].

A research was carried on a group of woodcutters in western and northern Poland, and found that after work there was an increase in disorders in different parts of the body, particularly in the case of the upper back, shoulders, elbows and knees while carrying load [35]. A study on workers of steel making company was conducted in Iran for clarifying prevalence of work-related musculoskeletal disorders (WMSDs) and associated lost work days due to load carrying [36]. Main physiological consequence of shift schedules is disruption of circadian rhythm which can have a deleterious effect on performance, sleep patterns, accident rates, mental health, and cardiovascular mortality, reproductive outcome effects may be linked to disruption of menstrual cycles [37].

A cross-sectional survey in New Zealand nurses, postal workers and office workers was conducted to study the association of psychosocial and physical risk factors in carrying loads with musculoskeletal disorders (MSDs) [38]. A pilot study was conducted for determination of the highest permissible spinal shrinkage during carrying of heavy loads [39]. The main aim of the study was to establish the highest permissible spinal shrinkage when under any working conditions, and a study was conducted on comparison of the physiological consequences of head-loading and back-loading for European and African women [40]. Maximum load limit of 15.4 kg and the workers rating was given in the moderate to heavy category [41]. A study on acute biomechanical responses to a prolonged standing exposure in a simulated occupational setting was conducted to investigate the impact of a prolonged

standing exposure on Rajasthan, India and identified work-related health problems experienced in carrying loads [42]. An attempt to evaluate ergonomically the posture and the musculoskeletal disorders (MSDs) of the female workers engaged in the brick manufacturing units of West Bengal, India was made [43]. A study on cleaning workers to evaluate the physical stress factors in cleaning work and their association with musculoskeletal disorders during carrying was conducted [44].

A pilot study on salt manufacturing unit workers of Rajasthan to identify the work-related health problems experienced by the salt workers [45]. It was found in a study that women who worked long hours have depression and moving from standard to long hours is associated with unhealthy weight gain for men [46]. In a pilot study for both sexes for load carrying that an evening shift is associated with increase in psychological distress levels [47]. Study of visual and musculoskeletal health disorders among computer professionals in NCR Delhi, India and reported that there was a gradual increase in visual complaints as the number of hours spent for working on computers increased and the same relation was found to be true for musculoskeletal problems as well [48]. It was concluded in a cross-sectional survey on Nigerian nurses that 84.4% of the nurses have had WMSDs once or more in their occupational lives [49]. In a study on New Zealand secondary school students, musculoskeletal symptoms were reported by 77.1% of the student. Symptoms were most prevalent in the neck, shoulders, upper back and lower back and the carriage of heavy schoolbags is a suspected contributory factor by [50]. Most of the studies cited above are cross-sectional. An issue when conducting this type of research concerns a study bias called the healthy worker effect. In cross-sectional studies, particularly among working population,

where details of exposures are gathered from a population, study populations are likely to be biased towards healthy individuals. The consequences of MSS are likely to depend on severity. This may reduce a person's activities and even increase absenteeism. A few studies are available on investigating the prevalence of reduced activities and absenteeism due to MSS. Risk factors for MSS involve individual, physical, psychosocial and organizational.

3.0 INDUSTRIES SELECTED FOR CURRENT RESEARCH

Construction workers are particularly at risk of WMSDs because they are frequently exposed to awkward postures and motions, such as lifting, bending or twisting sometimes for longer periods of time. Focusing on the postures resulting in WMSDs, there are five ergonomic problems in construction, working in same position for long periods, bending or twisting the back in an awkward way, working in a cramped position, working when injured or hurt and carrying heavy materials and equipment [51].

Agra is very famous for the shoe manufacturing. There are about 2500 small and medium scale shoe industries and some of the industries are exporting shoes to other countries e.g. Europe, Brazil, Mexico etc. In large number of shoe industries the manufacturing is totally manual, some of the industries are fully automated with assembly line etc. and few are combination of manual and automated, where some of the operations are done manually where few operations are performed automatically. Workers in shoe manufacturing units are working in awkward postures and also involved in carrying heavy loads .Verbal discussion with a group of workers in various manufacturing units have indicated that the workers are very much subjected to work related musculoskeletal problems.

Review of the literature indicates that much attention has not been paid to the following aspects of MSDs due to various risk factors for specific population.

4.0 SUMMRY OF GAPS

- The prevalence of musculoskeletal symptom (MMS) in industrially developing countries and developed countries is very high, and lot of studies is required in the selected industries.
- Association of job stressor with the prevalence of work-related musculoskeletal disorder.
- Association of social deprivation with the prevalence of musculoskeletal symptoms.
- Interaction between physical and psychosocial risk factors for MSS.
- Prevalence and risk factors of MSS and their consequences.
- Bias due to healthy worker effect and association between presence of MSS and consequences.
- Physiological cost during load carrying and its relationship with psycho-physiological perception on prevalence of MSDs.
- Effect of extending working hours and shift work on prevalence of MSDs
- Heart rate recovery cost and validity of heart rate variability measurement.

Looking to the above gaps in the research, a study is required to stress the importance of identifying the ergonomic risk factors responsible for WMSDs in construction and shoe manufacturing units and reducing their impact by proper applications of ergonomic principles, training, participative approach for safe, healthy, and comfortable work environment to reduce risk factors and obtain maximum productivity. Study should examine the prevalence, risk factors, and the interaction between physical and psychosocial work risk

factors for MSS and their consequences. Study may also be considering the effect of association of job stressors association of social deprivation, association between physical, psychosocial, organizational and environmental risk factors, prevalence of reduced activities and absenteeism extending working hours and shift work with physiological cost of load carrying and heart rate recovery cost for the specific population.

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